Chapter XIII

PSYCHOLOGICAL ASSESSMENT

Since 1961, psychological abnormalities have been ascribed to acute phenoxy herbicide exposure (Bauer, 1961). Subsequently, a wide range of psychological symptoms, including anxiety, depression, emotional instability, and asthenia have been reported following exposure (Monarca and di Vito, 1961; Kramer, 1974; Poland et al, 1971). Since many Vietnam veterans have expressed concern that their exposure to the defoliants during the war caused them to experience psychological and behavioral problems, the psychological functioning of the study participants was assessed in both the questionnaire and physical examination phases of the study. Overall, the responses of 1045 Ranch Handers, 1230 comparisons, and a subset of 773 originally selected comparisons were analyzed. Slight variations in these numbers occurred in some analyses due to missing data. Except where indicated, all analyses reported in this chapter used the data from the subset of originally selected comparisons. Each participant was asked whether he had ever experienced psychological illness. Additionally, six specific psychological dimensions were explored in detail in the questionnaire: depression, anxiety, erosion of skills, social isolation, fatigue, and aggressive or impulsive behavior. The questions used were selected from an extensive test battery, previously developed and validated (Robbins, 1982). More standardized measurements of psychological performance were obtained during the physical examination by the use of several standardized tests. The Cornell Index, the Minnesota Multiphasic Personality Inventory (MMPI), the Halstead-Reitan Battery and the Wechsler Adult Intelligence Scale (WAIS) were the primary testing instruments. Throughout much of this chapter, educational level (high school versus college) and rank (officer versus enlisted status) received special attention in all analyses. These variables are widely recognized as having major influences on psychological testing performance (Dalstrom, 1960) and their importance in the setting of the Air Force Health Study was very apparent. Dependent variables were stratified by education and rank, and in log-linear techniques, they were used as covariables. Table XIII-1 displays the education and rank distributions of the Ranch Hand and original comparison groups.

Table XIII-1

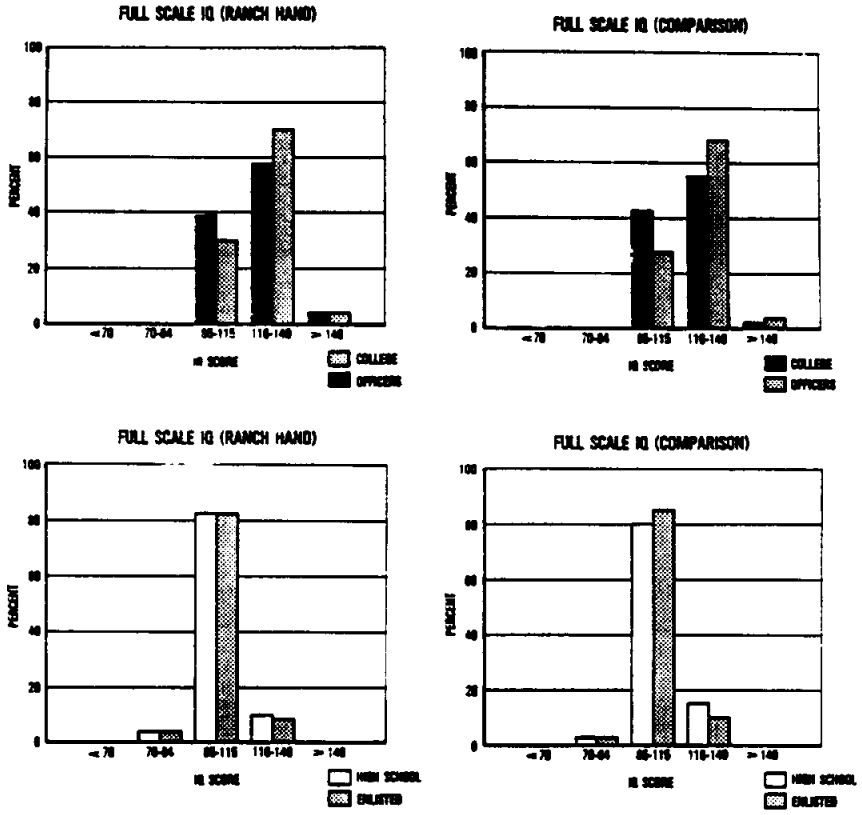
EDUCATION AND RANK DISTRIBUTION OF RANCH HAND AND ORIGINAL COMPARISON GROUPS

	Ranch Hand		Original Comparisons	
	High School	College	High School	College
Officers	54 (14.3%)	324 (85.7%)	53 (18.2%)	239 (81.8%)
Enlisted	521 (80.8%)	124 (19.2%)	377 (79.4%)	98 (20.6%)

Regardless of statistical technique or procedure, the analytic results of all psychological testing from the high school group closely mirrored those of the enlisted group, and college results matched those of the officer group, since, in general, the attainment of a college degree is a prerequisite for commissioning as an officer. However, 124 of the Ranch Hand enlisted and 98 of the original comparison enlisted personnel have college degrees as well. The similarities between these groups are graphically demonstrated in Figure XIII-1, where full scale IQ scores are compared. Since the variables of rank and education had identical impact on the analyses of psychological data, only the data from the educational analyses will be presented. The results of the rank analyses parallel those of education, and their presentation in this report would not further clarify the herbicide/dioxin issue.

Figure XIII-1

COMPARISON OF EDUCATIONAL ACHIEVEMENT AND RANK



1. Analysis of Questionnaire Data

a. Past History of Emotional or Psychological Illness

Detailed information concerning reported emotional or psychological illnesses was sought and, wherever possible, these illnesses were coded to the ICD-9-CM, 1980 edition. The unadjusted chi-square analyses of these data are presented in Table XIII-2. It is evident from these analyses that there were no statistically significant differences in the type of reported psychological illnesses between the Ranch Hand and either the entire comparison group or the subset of original comparison individuals.

Table XIII-2

DISTRIBUTION OF REPORTED PSYCHOLOGICAL ILLNESS BY TYPE OF ILLNESS

Type of Illness	Original Comparisons	Ranch Hand	Entire Group Comparison
Psychoses	4	6	4
Alcohol Dependence	2	5	7
Anxiety	4	9	5
Other Neuroses	6	16	9
	P = 0.91	P = 0.59	

b. Psychological Indices

A further comparison of the responses to the psychological subsections of the questionnaire was performed. Responses to the questions addressing each psychological dimension were combined in an index equal to the number of positive responses for each dimension. Group differences in the distribution of questionnaire responses were tested by the Kolmogorov-Smirnov two-sample test, and the results are tabulated in Table XIII-3 and XIII-4. The isolation index was analyzed in a discrete fashion, adjusted for educational level. The data for this index are presented in Table XIII-5. When the responses to the isolation scale are dichotomized as equal or greater than 14 or less than 14, a relative risk of 1.97 is seen, with a 95% confidence interval of 1.14 to 3.58. The number of individuals analyzed in the depression index is reduced, since this is primarily an index of severity, and those individuals not reporting depression were excluded from the analysis.

Table XIII-3

QUESTIONNAIRE PSYCHOLOGICAL INDICES
(HIGH SCHOOL EDUCATION)

Index	Group	N	Mean Score	Standard Deviation	Kolmogorov-Smirnov P Value
Fatigue	Ranch Hand	573	15.33	6.24	< 0.001
	Comparison	430	13.64	5.52	
Anger	Ranch Hand	573	11.27	4.74	0.002
	Comparison	430	9.99	3.64	
Erosion	Ranch Hand	572	22.34	7.90	< 0.001
	Comparison	429	20.00	6.70	
Anxiety	Ranch Hand	555	24.62	8.67	< 0.001
	Comparison	419	21.91	7.73	
Depression (Severity)	Ranch Hand	141	5.79	3.15	0.89
	Comparison	60	5.30	2.85	

Table XIII-4

QUESTIONNAIRE PSYCHOLOGICAL INDICES
(COLLEGE EDUCATION)

Index	Group	N	Mean Score	Standard Deviation	Kolmogorov-Smirnov P Value
Fatigue	Ranch Hand	447	12.79	4.55	0.88
	Comparison	335	12.83	4.45	
Anger	Ranch Hand	447	9.55	3.09	0.71
	Comparison	335	9.46	3.08	
Erosion	Ranch Hand	448	20.12	5.80	0.94
	Comparison	336	19.90	5.54	
Anxiety	Ranch Hand	437	21.23	6.74	0.63
	Comparison	328	20.51	5.96	
Depression (Severity)	Ranch Hand	60	5.22	2.80	*
	Comparison	39	4.46	2.11	

*Data too sparse for valid analysis

When an unadjusted analysis of reported depression (yes, no) was performed, there was a statistically significant group difference (P=0.002) with the Ranch Handers reporting more depression then the comparisons. This is not necessarily inconsistent with the analysis of severity (P=0.89).

Table XIII-5

ISOLATION INDEX, ADJUSTED FOR EDUCATION

	Index Score						
Group	≤5	6-7	8-9	10-11	12-13	≥14	Total
Ranch Hand	16	81	535	269	91	48	1040
Comparison	3	75	425	200	49	18	770

P = 0.002

The questionnaire responses to the questions concerning fatigue, anger, erosion, anxiety, and depression were analyzed with the exposure index, using a general linear model. When Blacks and non-Blacks were combined, the anger index was observed to be suggestively associated with exposure (P = 0.13) in officers but not in either of the enlisted occupational strata. All other exposure analyses had P values in excess of 0.40.

Educational level is a major influence on responses to the psychological assessment portion of the questionnaire. The responses to these questions did not differ between college educated Ranch Handers and comparisons, but all indices except depression did differ significantly in the high school educated participants. These variables were all subjectively measured, and the specific subsets of questions were not validated. It is unclear from these data whether these differences reflect a herbicide effect unique to the largely high school educated enlisted group or an educationally related response to a highly emotional public issue. This difference may also be a reflection of post-Vietnam stress in the frontline Ranch Hand personnel in contrast to the reduced stress in the comparison group stationed in support areas of SEA.

2. Physical Examination Parameters

During the physical examination, the Cornell Index, the Minnesota Multiphasic Personality Inventory (MMPI), the Halstead-Reitan Battery and the Wechsler Adult Intelligence Scales were used to assess psychologic functioning. Again, results were comparable whether using rank or educational attainment as stratification variables, and only the educational analyses are presented.

a. Cornell Index

The Cornell Index is a subjective 10 to 15 minute self-administered inventory of neuropsychiatric symptoms and complaints. It has been standardized and is a widely used testing instrument. Grading of the responses to the Cornell results in an overall index and separate indices for each of the ten subelements of the instrument. A total index score of 8 or less is considered to be normal. The overall index scores for the Ranch Hand and comparison groups were contrasted using the Kolmogorov-Smirnov technique after stratification for educational level (Table XIII-6). High school educated participants demonstrated a highly significant group differential (P <0.001) but the index scores in the college groups were not different.

Table XIII-6

ANALYSIS OF CORNELL INDEX BY GROUP
(KOLMOGOROV-SMIRNOV TWO-SAMPLE TEST)

Educational Level	Group	Mean Score	Standard Deviation	P Value
High School	Ranch Hand	9.21	10.35	< 0.001
	Comparison	6.44	7.79	
College	Ranch Hand	3.66	5.43	0.59
	Comparison	3.44	4.58	

The subelement scores were analyzed by log-linear techniques using 6 categories of response. These results are displayed in Table XIII-7, and the results of a similar analysis, using data from all available comparisons, are included as well. These results were all adjusted for educational level, since education was found to affect test scores in a highly significant manner (P <0.0001). Categorical analysis of the subelements revealed significant group differences between the Ranch Handers and the original comparisons in all areas except depression and the neurocirculatory system (NCS). This finding in depression on the Cornell Index is inconsistent with the significant observation noted in the responses to the in-home questionnaire, and may reflect the presence of differential reporting. The NCS scores were suggestive of group differences with a P value of 0.12. Analysis of the entire comparison group revealed similar findings.

Table XIII-7

CATEGORICAL ANALYSIS OF GROUP DIFFERENCES IN THE CORNELL INDEX
(ADJUSTED FOR EDUCATION)*

Parameter	P Value: Ranch Hand Versus Original Comparisons	P Value: Ranch Hand Versus All Comparisons
Fear and Inadequacy	0.02	0.06
Depression	0.39	0.16
Nervousness and Anxiety	0.002	0.009
Neurocirculatory System	0.12	0.14
Startle	0.004	0.04
Psychosomatic	0.002	0.002
Hypochondria	0.05	0.12
Gastrointestinal System	0.01	0.01
Sensitivity	0.08	0.29
Troublesomeness	0.06	0.06

* All of these parameters were significantly affected by education level ($P < 0.0001$)

Analysis of the Ranch Hand group's overall Cornell Index by degree of exposure was performed, using log-linear techniques. The Cornell Index was compared with exposure level (low, medium, and high) and education (high school and college) after stratification for occupation. In each occupational category, the index was clearly influenced by educational level but not by degree of herbicide exposure. Table XIII-8 contains the results of these analyses.

Table XIII-8

EXPOSURE ANALYSIS OF THE CORNELL INDEX
(ADJUSTED FOR EDUCATIONAL LEVEL)

Occupational Category	P Value: Cornell Versus Exposure	P Value: Cornell Versus Education
Officer	0.91	0.09
Enlisted, flying	0.53	0.05
Enlisted, ground	0.26	0.04

Analysis of the overall Cornell Index identified significant group differences among high school-educated individuals ($P < 0.001$), with the Ranch Handers having a significantly higher mean (abnormal) score. However, this

finding was not observed among the college educated individuals. Log-linear analyses of the Ranch Handers and original comparisons, adjusted for education, revealed significant differences in 6 of the 10 subscales of the index ($P \leq 0.05$) and borderline or suggestive findings in three others ($P \leq 0.12$). Despite these group differences, education adjusted exposure analysis of the overall Cornell Index did not identify any association between level of exposure and Cornell Index.

b. Minnesota Multiphasic Personality Inventory (MMPI)

The MMPI, a standardized set of 566 subjective self-administered questions concerning various aspects of behavior and personality, was completed by 1023 Ranch Handers, 767 original comparisons, and 1194 total comparisons. Scoring was performed by machine, using the standard criteria for normality of 30-70. The comparison of the distributional characteristics of the responses to each of the subelements of the MMPI are shown in Tables XIII-9 and XIII-10. The effect of educational level on psychological scores is again seen, with more suggestive and/or significant differences between groups appearing in the high school stratum. The validity scale was not different between Ranch Handers and comparisons in either educational stratum; however, the high school comparisons exhibited a greater degree of denial (K scale) than the high school Ranch Handers. Depression ($P = 0.16$), paranoia ($P = 0.19$) and hysteria scales ($P = 0.12$) were suggestive of group differences in the high school stratum and significant differences were noted in the masculinity/femininity, hypochondria, mania/hypomania, and social introversion scales, with comparisons faring better than the Ranch Handers. The college stratum demonstrated borderline significance in the masculinity/femininity scale ($P = 0.09$) and a significant difference ($P = 0.04$) in social introversion. The masculinity/femininity scale is heavily influenced by the range of interests held by the participants. As individuals increase their education and broaden their interests beyond traditional "male" activities, the score tends to rise (Lachar, 1974). This is demonstrated by the means of 57.87 to 59.15 in the college stratum and means of 54.85 to 55.94 in the high school group. The consistent finding of significance in social introversion, with the Ranch Handers being more inwardly directed, is striking, but its clinical relevance is unclear. The percent of the Ranch Handers and comparisons exhibiting abnormal MMPI scores (greater than 70 or less than 30) are shown in Table XIII-11 for those scales with suggestive or significant findings.

The increased score on the denial (K) scale of the MMPI for the enlisted comparison group may be an indication of a relative differential in reporting between the two groups. When considered in the light of an increased enlisted Ranch Hand hypochondria scale on both the Cornell Index and the MMPI, overreporting in the Ranch Hand group is indicated.

Table XIII-9

ANALYSIS OF MMPI TESTING IN HIGH SCHOOL-EDUCATED PARTICIPANTS
(RANCH HAND N = 575; COMPARISON N = 430)

Parameter	Group	Mean Score	Standard Deviation	Kolmogorov-Smirnov P Value
Validity	Ranch Hand	1.85	4.54	0.99
	Comparison	1.73	4.07	
Defensiveness (L Scale)	Ranch Hand	51.99	7.84	0.98
	Comparison	52.03	8.15	
Consistency (F Scale)	Ranch Hand	51.95	9.29	0.44
	Comparison	50.65	7.16	
Denial (K Scale)	Ranch Hand	53.95	8.86	0.03*
	Comparison	55.63	8.12	
Hypochondria	Ranch Hand	59.74	13.36	0.05
	Comparison	57.22	10.95	
Depression	Ranch Hand	60.47	13.98	0.16
	Comparison	58.39	11.96	
Hysteria	Ranch Hand	60.12	9.96	0.12
	Comparison	58.90	8.23	
Psychopathic/Deviate	Ranch Hand	56.38	11.00	0.86
	Comparison	55.89	10.52	
Masculinity/Femininity	Ranch Hand	55.94	8.32	0.01
	Comparison	54.85	8.94	
Paranoia	Ranch Hand	51.72	8.66	0.19
	Comparison	50.68	8.33	
Psychasthenia (Anxiety)	Ranch Hand	57.27	12.23	0.47
	Comparison	55.59	10.07	
Schizophrenia	Ranch Hand	57.53	13.42	0.45
	Comparison	55.97	9.71	
Mania/Hypomania	Ranch Hand	56.03	10.36	0.01
	Comparison	54.49	10.31	
Social Introversion	Ranch Hand	52.31	10.38	0.006
	Comparison	50.80	9.50	

*Comparisons greater than Ranch Hand

Table XIII-10

ANALYSIS OF MMPI TESTING IN COLLEGE-EDUCATED PARTICIPANTS
(RANCH HAND N = 448; COMPARISON N = 337)

Parameter	Group	Mean Score	Standard Deviation	Kolmogorov-Smirnov P Value
Validity	Ranch Hand	1.48	4.14	0.47
	Comparison	1.95	4.49	
Defensiveness (L Scale)	Ranch Hand	50.26	7.68	0.99
	Comparison	50.33	7.29	
Consistency (F Scale)	Ranch Hand	48.74	5.84	0.99
	Comparison	48.44	5.36	
Denial (K Scale)	Ranch Hand	58.46	7.53	0.99
	Comparison	58.41	7.64	
Hypochondria	Ranch Hand	55.42	9.34	0.96
	Comparison	54.65	8.45	
Depression	Ranch Hand	55.34	10.77	0.99
	Comparison	54.57	9.98	
Hysteria	Ranch Hand	59.75	7.38	0.98
	Comparison	59.32	7.01	
Psychopathic/Deviate	Ranch Hand	55.21	9.33	0.68
	Comparison	55.66	8.90	
Masculinity/Femininity	Ranch Hand	59.15	8.72	0.09
	Comparison	57.87	8.98	
Paranoia	Ranch Hand	53.62	6.96	0.63
	Comparison	53.26	6.64	
Psychasthenia (Anxiety)	Ranch Hand	53.62	8.04	0.84
	Comparison	54.18	8.36	
Schizophrenia	Ranch Hand	54.70	7.94	0.79
	Comparison	54.89	7.88	
Mania/Hypomania	Ranch Hand	55.22	9.55	0.51
	Comparison	54.05	10.03	
Social Introversion	Ranch Hand	46.83	8.67	0.04
	Comparison	47.50	7.98	

Table XIII-11

MMPI ABNORMALITY BY GROUP

Level	MMPI Scale	Group	% Below 30	% Above 70
High School	Denial	Ranch Hand	0.0	1.7
		Comparison	0.0	3.7
	Hypochondria	Ranch Hand	0.0	18.1
		Comparison	0.0	10.9
	Depression	Ranch Hand	0.2	18.1
		Comparison	0.0	12.2
	Hysteria	Ranch Hand	0.0	14.1
		Comparison	0.0	7.9
	Masculinity/ Femininity	Ranch Hand	0.0	4.5
		Comparison	0.0	5.6
	Paranoia	Ranch Hand	0.0	2.4
		Comparison	0.0	1.9
	Mania/Hypomania	Ranch Hand	0.3	8.5
		Comparison	0.2	8.6
	Social Introversion	Ranch Hand	0.0	6.8
		Comparison	0.0	4.9
College	Masculinity/ Femininity	Ranch Hand	0.0	11.6
		Comparison	0.0	11.0
	Social Introversion	Ranch Hand	0.0	1.6
		Comparison	0.3	1.8

Log-linear analysis of the MMPI data, using dichotomous (normal/abnormal) responses was also conducted (Table XIII-12). Educational level was again found to exert a highly significant influence in all scales, with P values all less than 0.01.

Table XIII-12

LOG-LINEAR ANALYSIS OF THE MMPI SCALES BY GROUP
(ADJUSTED FOR EDUCATION)

Scale	P Value of Group Difference
Hypochondria	< 0.001
Depression	0.02
Hysteria	0.002
Psychopathic/Deviate	0.39
Masculinity/Femininity	0.84
Paranoia	0.26
Psychasthenia	0.21
Schizophrenia	0.007
Mania/Hypomania	0.52
Social Introversion	0.32

Several of these analyses appear to be inconsistent with the results of the Kolmogorov-Smirnov testing, making inference more difficult. Most of the statistically significant group differences found in the distributional analyses were in the high school group, but the log-linear analysis revealed highly significant group differences (P = 0.02) between the Ranch Hand and comparison groups after adjustment for education. Matched pair analyses, using the original comparison subset, were conducted on the hysteria, hypochondria, and masculinity/femininity scales, with respective P values of 0.02, 0.02, and 0.66. These results mirror those of the log-linear analysis in Table XIII-12.

The initial group analyses of the MMPI were performed without consideration for the variable of race. A repeat analysis of MMPI scores was also conducted for the 63 Ranch Handers and 45 originally selected comparisons who were Black. The results of this analysis are presented in Table XIII-13. Wherever the sample size permitted, the analyses were adjusted for education; however, sparseness of data prevented adjustment in the analysis of the psychasthenia, schizophrenia, and masculinity/femininity scales and prevented any analysis for the paranoia and social introversion scales. The borderline significant finding in the schizophrenia scale (P = 0.07) is somewhat parallel to the significant P value for schizophrenia (P = 0.007) in Table XIII-12. These findings do not suggest that the factor of race is at all responsible for the overall differences in MMPI scores between the Ranch Hand and comparison groups.

Table XIII-13

MMPI ANALYSIS AMONG BLACK PARTICIPANTS

Scale	Adjusted for Education	P Value of Group Difference
Hypochondria	Yes	0.15
Depression	Yes	0.91
Hysteria	Yes	0.31
Psychopathic/Deviate	Yes	0.73
Mania/Hypomania	Yes	0.70
Psychasthenia	No	0.20
Schizophrenia	No	0.07
Masculinity/Femininity	No	0.31
Paranoia	N/A	-
Social Introversion	N/A	-

Exposure analysis of the Ranch Hand group, using log-linear techniques revealed a mixed pattern of significant, borderline and suggestive findings. These results are summarized in Table XIII-14. Education remains a significant factor, but consistency across occupational groups is not evident, since stratification by occupational group mirrored stratification by education. Table XIII-15 displays the exposure index data, and the percentage of abnormal MMPI scale results, for the exposure analyses with P values of concern. Only the hysteria scale in the officers attending college and the psychopathic deviate scale in both high school and college officers showed consistent increases in abnormality with increasing exposure. However, the number of abnormal scores in all of these scales was quite low and inferential accuracy is compromised.

Table XIII-14

P VALUES OF THE MMPI/EXPOSURE ANALYSES
(ADJUSTED FOR EDUCATION)

	P Value Parameter Versus Exposure			P Value Parameter Versus Education		
		Enlisted			Enlisted	
Parameter	Officer	Flying	Ground	Officer	Flying	Ground
Hypochondria	0.21	0.97	0.02	0.18	0.10	0.03
Depression	0.70	0.11	0.16	0.46	0.12	0.27
Hysteria	0.21**	0.76	0.0005	0.34	0.62	0.04
Psychopathic Deviate	0.001*	1.00	0.15	0.17	0.20	0.16
Masculinity/Femininity	0.09	0.81	0.09	0.28	0.04	0.005
Paranoia	1.00	0.64	0.53	0.72	0.83	0.20
Psychasthenia	0.89	0.05	0.48	0.29	0.56	0.07
Schizophrenia	0.09	0.12	0.73	0.43	0.50	0.03
Mania/Hypomania	0.32	0.13	0.29	0.86	0.81	0.41
Social Introversion	0.39	0.33	0.78	0.77	0.93	0.02

*Significant confounding by education present
**Significant three-way interaction present

Table XIII-15

DOSE RESPONSE PATTERNS

Parameter	Group	Exposure Level	Number Normal	Number Abnormal (%)
Hypochondria	Enlisted Ground	Low	110	38 (25.7%)
		Medium	153	25 (14.0%)
		High	119	29 (19.6%)
Depression	Enlisted Flying	Low	48	10 (17.2%)
		Medium	41	18 (30.5%)
		High	55	11 (16.7)
	Enlisted Ground	Low	111	37 (25.0%)
		Medium	148	30 (16.9%)
		High	119	29 (19.6%)
Hysteria*	Officers (High School)	Low	10	0 (0%)
		Medium	14	5 (26.3%)
		High	24	0 (0%)
	Officers (College)	Low	97	3 (3.0%)
		Medium	104	5 (4.6%)
		High	91	9 (9.1%)
	Enlisted Ground	Low	115	33 (22.3%)
		Medium	163	15 (8.4%)
		High	132	16 (10.8%)
Psychopathic/Deviate*	Officers (High School)	Low	10	0 (0%)
		Medium	19	0 (0%)
		High	23	1 (4.2%)
	Officers (College)	Low	100	0 (0%)
		Medium	102	7 (6.4%)
		High	90	10 (10%)
	Enlisted Ground	Low	127	21 (14.2%)
		Medium	164	14 (7.9%)
		High	131	17 (11.5%)
Masculinity/Femininity	Officers	Low	105	5 (4.5%)
		Medium	113	15 (11.7%)
		High	111	13 (10.5%)
	Enlisted Ground	Low	135	13 (8.8%)
		Medium	172	6 (3.4%)
		High	136	12 (8.1%)
Psychasthenia	Enlisted Flying	Low	54	4 (6.9%)
		Medium	48	11 (1.9%)
		High	62	4 (6.1%)
Schizophrenia	Officers	Low	108	2 (1.8%)
		Medium	119	9 (7.0%)
		High	121	3 (2.4%)
	Enlisted Flying	Low	55	3 (5.2%)
		Medium	49	10 (16.9%)
		High	59	7 (10.6%)
Mania/Hypomania	Enlisted Flying	Low	53	6 (10.2%)
		Medium	50	9 (15.3%)
		High	63	3 (4.8%)

*Data are presented by educational level when the education/exposure interactions are statistically significant.

Analysis of the MMPI data from the Ranch Hand and original comparison groups revealed significant group differences in the hypochondria, depression and hysteria scales ($P \leq 0.02$), after adjustment for education. Stratified analysis based on level of education revealed statistically significant group differences for the hypochondria and masculinity/femininity scales ($P \leq 0.05$). However, there were no statistically significant group differences among college-educated individuals, and only in the masculinity/femininity scale was borderline significance reached ($P = 0.09$). Exposure analyses did not reveal any consistent patterns of statistical significance between occupational categories, level of exposure and MMPI scores.

c. Halstead-Reitan

The Halstead-Reitan Neuropsychological Test Battery was administered to each participant to assess the functional integrity of the central nervous system. An impairment index for each participant was calculated based upon the scores of the category, tactual performance, speech-sounds, Seashore rhythm, and finger-tapping portions of the battery. The impairment index ranged from zero to seven, based on the number of subtests in which the participant scored abnormally. Impairment was declared if the index equalled or exceeded three. Larger numbers of participants were deleted from these analyses; since seven distinct tests contributed to the impairment index. The absence of any one made calculation of the index impossible. Analysis of dicotomous variables (normal/abnormal), adjusted for education, revealed no overall group differences ($P = 0.74$).

A categorical analysis, unadjusted for educational level, was performed. The data and the results of the unadjusted analyses of the Ranch Hand group, the entire comparison group and the subset of original participants are presented in Table XIII-16.

Table XIII-16

UNADJUSTED HALSTEAD-REITAN SCORES BY GROUP

Impairment Index	Original Comparisons N = 559		Ranch Hand N = 771		All Comparisons N = 883	
0	85		124		141	
1	162	66.5%*	226	66.5%*	248	66.0%*
2	125		163		194	
3	77		126		134	
4	60		68		85	
5 or more	50		64		81	
	$x^2 = 3.18$		$x^2 = 1.35$			
	$P = 0.67$		$P = 0.93$			

* Cumulative % for Impairment Index 0,1,2

Analyses adjusted for education were carried out on the Ranch Handers and the original subset of comparisons (Table XIII-17). Education was again seen to be a significant factor ($P < 0.0001$).

Table XIII-17

HALSTEAD-REITAN ANALYSIS BY GROUP AND EDUCATION

Educational Level	Group	Degree of Impairment					
		0	1	2	3	4	5 or Greater
High School	Ranch Hand	45	108	88	80	54	56
	Comparison	29	69	69	49	38	37
College	Ranch Hand	79	118	75	46	14	8
	Comparison	56	93	56	28	22	13

P Value, adjusted for education = 0.57

An exposure index analysis was also accomplished on the data from the Ranch Hand group. As shown in Table XIII-18, educational level was a significant covariable in the officer and enlisted flying groups, but there were no significant relationships between herbicide exposure and Halstead-Reitan performance.

Table XIII-18

HALSTEAD-REITAN IMPAIRMENT AND EXPOSURE

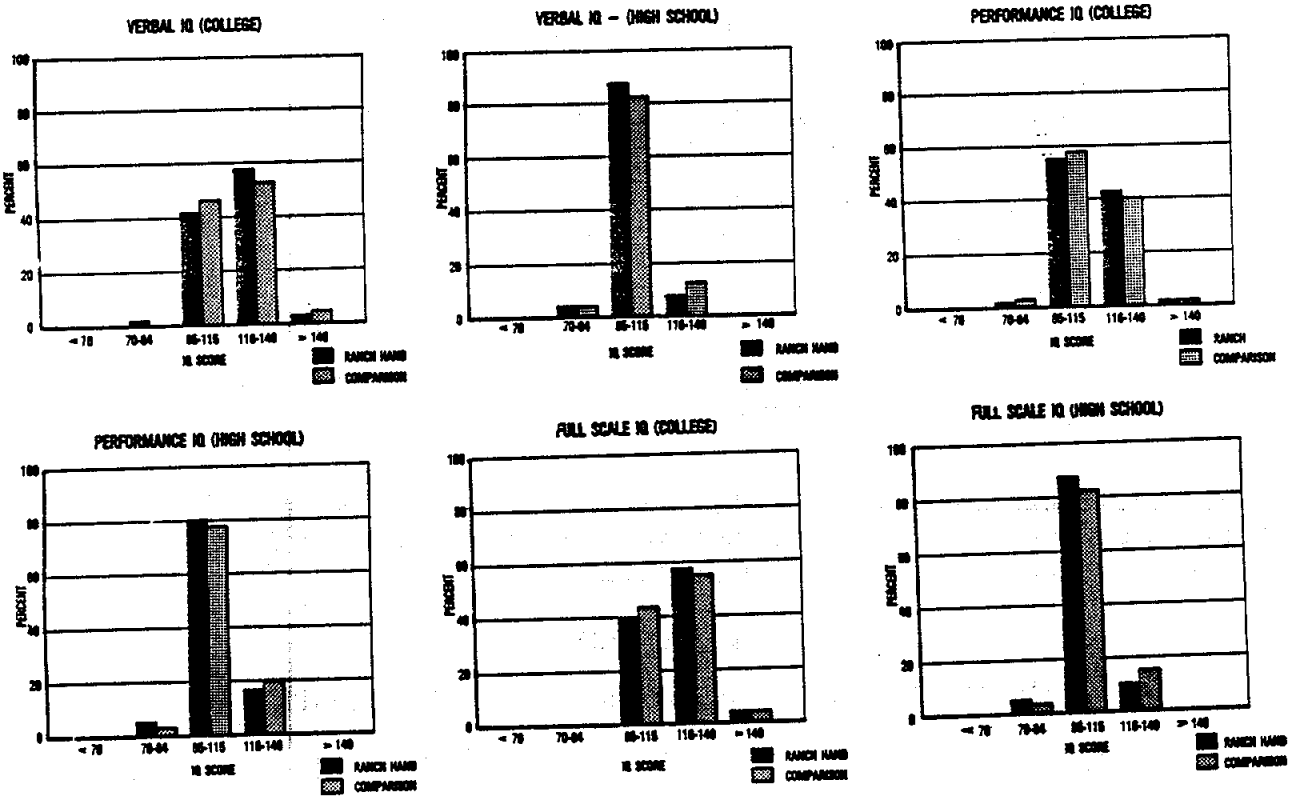
Occupational Group	Adjusted P Values	
	Halstead-Reitan Versus Exposure	Halstead-Reitan Versus Education
Officers	0.88	0.002
Enlisted Flying	0.44	0.05
Enlisted Ground	0.82	0.62

d. Wechsler Adult Intelligence Scale (WAIS)

WAIS testing was completed on 1022 Ranch Handers and 733 original comparison individuals. The test was administered and scored in the standard manner by certified clinical psychologists and psychological technicians. As noted previously, intelligence scores (IQ) by rank were equivalent to IQ scores by education. The distributions of verbal, performance and full-scale IQ scores, by educational level and group, are shown in Figure XIII-2.

Figure XIII-2

FREQUENCY DISTRIBUTION IQ SCORES BY EDUCATIONAL LEVEL AND GROUP



The IQ scores demonstrated consistent patterns within each educational stratum. A slight increase in the proportion of both Ranch Hand and comparison college graduates, with performance IQ's between 85 and 115, was noted. These college graduates, with performance IQ's between 85 and 115, was noted. These distributions were tested for group differences by the Kolmogorov-Smirnov procedure. Suggestive but nonsignificant differences were noted for performance and full-scale IQ's in the high school stratum, but no differences were found among the college-educated group. These data are shown in Table XIII-19.

Table XIII-19

DISTRIBUTIONAL ANALYSIS OF IQ SCORES

Scale	Education	Group	Mean Score	Standard Deviation	P Value
Verbal	High School	Ranch Hand	110.61	10.65	0.39
		Comparison	101.73	11.34	
	College	Ranch Hand	117.00	12.97	0.73
		Comparison	116.84	13.73	
Performance	High School	Ranch Hand	102.40	11.38	0.14
		Comparison	104.14	11.86	
	College	Ranch Hand	113.70	12.62	0.50
		Comparison	112.37	13.33	
Full Scale	High School	Ranch Hand	101.18	10.71	0.15
		Comparison	102.74	11.32	
	College	Ranch Hand	117.30	12.96	0.37
		Comparison	116.59	13.82	

The distributions were observed to identify outliers, and the percentage of participants with scores in the abnormal range (below 85) was determined. These results are shown in Table XIII-20.

Table XIII-20

ABNORMAL IQ SCORE BY GROUP AND EDUCATIONAL LEVEL

Educational Level	Scale	Group	% Below 85	% Above 115
High School	Verbal	Ranch Hand	3.7	9.8
		Comparison	3.3	13.7
	Performance	Ranch Hand	5.4	14.3
		Comparison	3.7	18.8
	Full	Ranch Hand	4.0	10.6
		Comparison	3.5	15.1
College	Verbal	Ranch Hand	0.9	58.8
		Comparison	0.3	54.1
	Performance	Ranch Hand	1.1	43.9
		Comparison	1.8	41.1
	Full	Ranch Hand	0.7	61.1
		Comparison	0.3	56.2

Analysis of the WAIS testing scores of the Ranch Hand group, by level of herbicide exposure, revealed no consistent differences in IQ scores. The P values derived from these analyses are presented in Table XIII-21 and show only one statistically significant association (P = 0.04).

Table XIII-21

RESULTS OF IQ SCORES BY EXPOSURE ANALYSIS

Scale	Occupational Group	P Value
Verbal	Officers	0.99
	Enlisted Flying	0.34
	Enlisted Ground	0.82
Performance	Officers	0.99
	Enlisted Flying	0.04
	Enlisted Ground	0.18
Full Scale	Officers	0.99
	Enlisted Flying	0.23
	Enlisted Ground	0.25

2. Summary

In this chapter, a large number of variables were analyzed using several techniques and multiple assessments. Consistent differences between high school-educated Ranch Handers and high school-educated original comparisons are seen throughout these analyses. With the exception of a single statistically significant result for social introversion (P = 0.04), these group differences are not apparent in the college educated stratum. Unstratified but educationally adjusted analyses of the MMPI scores did, however, reveal group differences which were more like those of the high school stratum. Exposure analyses did not reveal any patterns suggesting any association between psychological testing results and level of herbicide exposure. The relative risks, confidence intervals, and shifts in means for the dependent variables analyzed in this chapter are included in Appendix XVIII.

Table XIII-22

PSYCHOLOGICAL ANALYSIS SUMMARY
(RANCH HAND VERSUS ORIGINAL COMPARISON GROUP)

	Analytic Strategy (P Values)					
	Adjusted for	Stratified Analysis		Exposure Analysis		
Parameter	Education	High School	College	Off	Enl Fly	Enl Gnd
Questionnaire Indices						
Fatigue		<0.001	NS*			
Anger		0.002	NS			
Erosion		<0.001	NS			
Anxiety		<0.001	NS			
Isolation	0.002					
Depression (Severity)		0.89				
Cornell Index		<0.001	NS	NS	NS	NS
Fear and Inadequacy	0.02					
Depression	NS					
Nervousness and Anxiety	0.002					
Neurocirculatory	0.12					
Startle	0.004					
Psychosomatic	0.002					
Hypochondria	0.05					
Gastrointestinal	0.01					
Sensitivity	0.08					
Troublesomeness	0.06					
MMPI						
Hypochondria	<0.001	0.05	NS	NS	NS	0.02
Depression	0.02	0.16	NS	NS	0.11	0.16
Hysteria	0.002	0.12	NS	NS	NS	0.001
Psychopathic Deviate	NS	NS	NS	0.001	NS	0.15
Masculinity/Femininity	NS	0.01	0.09	0.09	NS	0.09
Paranoia	NS	0.19	NS	NS	NS	NS
Psychasthenia	NS	NS	NS	NS	0.05	NS
Schizophrenia	0.007	NS	NS	0.09	0.12	NS
Mania/Hypomania	NS	0.01	NS	NS	0.13	NS
Social Introversion	NS	0.006	0.04	NS	NS	NS
Halstead-Reitan	NS			NS	NS	NS
IQ Scores						
Verbal		NS	NS	NS	NS	NS
Performance		0.14	NS	NS	0.04	0.18
Full Scale		0.15	NS	NS	NS	NS

*Nonsignificant; P > 0.20

The results of the analyses of the psychological data are summarized in Table XIII-22, and demonstrate a greater degree of statistically significant group differences in the more subjective measurements (questionnaire and Cornell Index) than are observed in the more objective assessments (Halstead-Reitan and WAIS). The effect of differential reporting in this evaluation is as yet difficult to assess. However, the high school-educated Ranch Handers did have higher scores on the hypochondria scale of the MMPI and the psychosomatic portion of the Cornell Index than did the appropriate comparisons. Additionally, the high school-educated comparisons scored higher on the MMPI K Scale (denial). These findings suggest that differential reporting may be influencing the analytic results of the in-home questionnaire and the Cornell Index. There may also be a differential response to the intense media interest in the herbicide/dioxin issue between the high school and college strata in this study. The role of "Post Vietnam Stress" in these findings is also unclear at this time. Further clarification of these factors and their impact must await analysis of the data from the follow-up phase of the study. Based on the psychological data collected during the initial in-home questionnaire and physical examination, there is no convincing evidence suggesting the presence of an adverse effect on emotional health caused by herbicide exposure.